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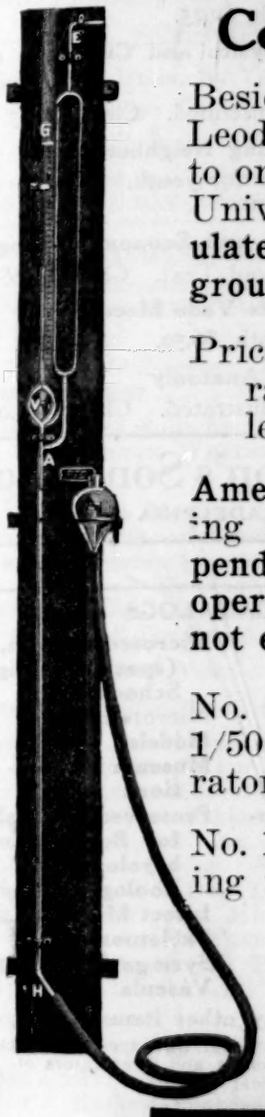

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THE RECORD OF SCIENCE[1]

One learns by adversity—at least such is the popular belief, although the press dispatches from Europe during the past few months would seem to give the lie to this old adage. It used to be my fate to encounter at frequent intervals a genial friend of great distinction in the field of physics and astronomy, long engaged in high administrative functions, an alumnus of this university—altogether a man of great weight and substance, who endeavored each time we met to overwhelm my cherished ambitions by bringing forth with great gusto this aphorism, "Bibliography is the platitude of research!" So much did this phrase please him that he paraded it on many occasions, and I confess I used to dodge around the corner to avoid its rotund and sonorous condemnation of my own ways and works. I hope to show you that bibliography is the *foundation* of research, and that however level and flat that foundation may be, however dull may be the task of laying it deep and strong, no lasting and lofty superstructure may safely be reared, save on the secure footing of a knowledge of previous work done by others, a knowledge resting necessarily even in the field of science on the much despised labor of the bibliographer.

There is prevalent on every university campus, I suppose, an impression—not among students alone—that the various branches of human knowledge are for practical purposes divided into two groups, the laboratory sciences and the book sciences. This is an extremely convenient and easy grouping—and it has certain elements of truth in its facile cleavage of the field of inquiry. But it is essentially inaccurate in that it ignores a fundamental factor common alike to research with the microscope

[1] Address at the annual meeting of the Michigan Chapter of Sigma Xi.

or the blow-pipe and research with the written word or philosophic logic as its instrument. That factor is the *record* of what has been known and spread abroad by previous inquirers. The processes of human inquiry depend fundamentally on memory—and in the case of the pursuit of knowledge in our own day on the *record in print* of what the race has done or thought or attempted. It makes little difference whether the inquiry be into the morphology of the early Italic dialects of the Latin tongue, or into the function of the ductless glands of guinea pigs—the essential processes are alike these: observation and the gathering of data by experiment or by compilation; a study of the previous work done in the same field with a critical examination both of processes and results; a synthesis from one's own observations and from the recorded observation of others; and finally such reflection (or theorizing) on the results as may lead to correlation of this piece of investigation with the sum of human knowledge, perhaps (occasionally) in a way to affect human activity. The so-called "book sciences" employ methods in no way essentially different from those long approved in the so-called "natural sciences." All of them alike depend on careful study of previous work as an initial step and on the publication of results as a final process. No facile popular division can separate "book-knowledge" from "experimental research." Experiment without "book- knowledge" is generally not research in the true sense, even though it occasionally leads an Edison into discoveries of untold value to the world.

There is, notwithstanding, a justification for this distinction popular among college students. The manner of teaching the natural sciences has been completely revolutionized in the last forty years. Every one knows that subjects formerly taught from text-books are now taught chiefly in laboratories. Emphasis is now laid on accurate observation, correct inference from observation, ability to report the sum of observation succinctly and truthfully. An equipment elaborate in itself, impressive in amount and cost, is properly thought needful to the task of teaching the natural sciences. Each student is considered (I suppose) an embryo Pasteur or Rowland, and is laboriously inducted into scientific methods by requiring him to develop manual dexterity in the use of instruments, and training him to produce neat and correct note-books. Naturally the mass of students is found in the elementary courses. It is only the smaller number resulting from a process of natural (or at least academic) selection which ever gets to the "journal club" stage, and becomes personally aware of the existence of the enormous and multifarious record of scientific knowledge. That the method of teaching should of itself influence the student's conception of the subject-matter of instruction is both natural and inevitable. That undue weight should be given by their elders to manner and form of presentation is quite another matter. It is, however, impossible to escape the conclusion that many a scientist thinks that he is freed by the very nature of his work from a supposed taint of bookishness. He gives thanks that he is not as other men, as these historians and philologians—or even this librarian.

There is a real danger lurking in this attitude; and we are not without evidence that (whether from this source or more subtle workings of the laws of auto-suggestion) this tendency to pride himself on being strictly a scientific and not a book man has bred a habitual attitude of neglect of the record side of scientific inquiry which has already been disastrous in too many instances. The conviction that apparatus and laboratories are essential—a perfectly sound and indeed a fundamental thesis—has somehow led to the notion that they and they alone constitute the requirements not only of instruction, but of research as well. This tendency—and I do not exaggerate it in the least—has made too many folk unmindful of the long history of science, has bred an attitude which can best be described as almost wholly lacking in the historic sense. And without a sense of the historic setting of his work, a man is almost as hopeless as is the man who lacks a sense of humor! You can not argue with one or the other! In fact I dare go farther and affirm that only by the combinations of the historical and the experimental methods can any work of first-rate

importance be produced in any field of knowledge.

By this time, I fear you may be saying to yourselves that whatever the platitude of research may mean as applied to bibliography the bibliographer is in truth indulging in platitudes! No one need set up a man of straw for the pleasure of knocking him over. There is no point to my contention, if it be true that students of the natural sciences in America have rigorously employed both the historical and the experimental method. The great leaders have unquestionably done just that. But how many *great* leaders have we produced in America? May not one reason for our surpassing excellence in the practical arts and our rather scant array of great names in pure science lie exactly in the absence of the historical record of science from American institutions in the past century? It is difficult, perhaps one may say it is impossible, to get a correct historical perspective without a really good and strong library to furnish the means of study. No amount of second-hand information will ever take the place, for the real student, of the original documents. This is just as true in the pure and applied sciences as it is in history, economics or letters. Imagine an astronomer trying to carry on intelligent research in the observational field alone, without the great publications of the nineteenth century at his hand for previous study and occasional consultation. Yet that is precisely what scores of astronomers have done in this land, and are doing to-day. The example might be multiplied ten-fold. Really good libraries of scientific books are scarce enough in America to-day. Before 1870 they did not exist, save perhaps at Cambridge in Massachusetts. No one of them is yet fully equipped to meet all the reasonable demands of scientists for a record of the progress of knowledge. I say this from my own experience. For eight years I labored—too often in vain—to serve the scientists in the various bureaus in Washington with books they needed. My work was in the third largest library in the world. This fact is significant. May I enlarge upon it?

America is not a nation alone—it is a continent. Distances are enormous. Because Mr. Henry E. Huntington has in San Gabriel in California a very rare early English book on American fishes or plants, it does not follow that it is of much use to a Harvard student who requires the exact language of the original description of a particular species. The extraordinary collection of early botanical works in the library of Notre Dame University is not easily helpful to the botanists of the Bureau of Plant Industry. These are but two concrete examples of the physical size of this land. You know what it means to journey to Washington in the hot weather of summer—yet you must make the trip in vacation to consult some volume found in America only in the Library of Congress and too rare or too fragile to permit its loan. The situation is quite different in Europe. No university in the British Isles is as far from the British Museum as Ann Arbor is from New York or Washington. Even from Aberystwyth or remoter Aberdeen the trip is less in time consumed than from here to Albany. No French university professor is so far in time from the Bibliothèque Nationale as we from our national library, and we (be it remembered) are much nearer than our colleagues to the west and south. In Germany the Prussian State Library and in Austria the great libraries at Vienna are relatively near the universities. If one goes to London, it is but eight hours to Paris. Between the two largest libraries in the world a scholar can usually find *all* he needs in the way of books. I need not point out the contrast in this country and in Canada. These distances from great library centers have not been without influence on American scholarship.

In fact we may safely say that up to about 1900 there were very few strong scientific libraries in America, libraries in which the record of science could be traced with precision. There has been an almost startling change since the opening of this century. We have much yet to do. We can overcome the obstacles of distance and youth only by further heroic efforts. But we have most surely made progress. We have now a round dozen libraries really strong from an absolute standard. And they are growing stronger every day. We have many special libraries in various fields of science which have been highly developed in their own line—of these the most conspicuous is prob-

ably the great medical library of the Surgeon General's Office in Washington. We have developed library technique and library service far beyond those of Europe. But we have not developed to the point where the historic sense is necessarily fostered and the historic instinct adequately satisfied. That will come with time. Meantime we may perhaps expect that instruction will take cognizance of this changed situation and will by its pressure aid to improve further the resources in the way of books.

For, of course, instruction in historic method and in the use of books as tools is utterly impossible without really good libraries. It is folly to expect students—even advanced students of high promise—to acquire a proper attitude toward their predecessors and their contemporaries without the publications of both at hand in full numbers. It is useless—or nearly so—to teach exact methods of ascertaining the present state of knowledge about any particular problem, when you know it is being worked on in New Zealand and South Africa—and your library lacks the New Zealand and South African transactions and journals. I need not dwell on this painful fact. You know more about it than I do. I suggest, therefore, that the production of truly strong men in your various lines of study depends to a very considerable degree on a sufficient provision of books in our libraries here on this campus. That provision depends on many factors—of which money is by no means the only one, as I hope to show you in the course of these remarks.

For the publication of the results of observation in the field of science has taken many (and frequently strange) forms. We ordinarily think of books as just books—perhaps unconsciously influenced by the manufacture or the perusal of text-books. Ordinary monographs of the text-book type do, it is true, make the staple contents of book-sellers' stocks and ordinary library shelves. But they are perhaps the least important element in the complicated record of science. They are too generally compilations—not the results of original research. And their tendency to accumulate on those very shelves has perhaps had no small part in that neglect of the historic aspect of scientific inquiry to which allusion has just been made. The large and imposing monograph is the exception. True, it generally remains valuable and "well-spoken-of" long after the smaller books have passed to the limbo of things with a "merely historical" interest. Moreover, the hugh monographs which have appeared in some scientific fields—such things as Audubon's *Birds of North America*, for example, or the monumental publications of von Humboldt—have been so costly that save to a favored few they have been merely names and names alone. I am inclined to consider this costliness in relation to our American libraries (until a recent date) a very real factor in the neglect of the older literature. It has simply cost too much to be known by the average student.

Perhaps the most extremely particularized form of monograph is the doctoral thesis. Most folk whom I have met have lost interest in theses within a few years after their own have been promptly forgotten by their colleagues. It is hard to get any money for a lot of dissertations—particularly for the thin German products. The more extended French dissertations usually masquerade as real books. But historically theses for the doctorate have a great value—particularly those printed before 1800. Few people recall the pleasing habit of the earlier centuries which practically compelled the candidate *respondens* to pay for the publication of the work of his *præses* under the guise of a doctoral dissertation. A few years since a committee on botanical nomenclature—or rather, members of it resident in Washington—began to torment me for the dissertations of the pupils of Linnæus, which, they averred, contained some of the great master's best work. It was an interesting quest which became exciting when I discovered a bundle of these much desired little Upsala dissertations carefully tied up and labeled among a group of several thousand Smithsonian exchanges from Sweden. By the liberal use of the photostat, reproducing copies from the Harvard Library and the Torrey Botanical Club the series was made, I believe, complete, and the committee supplied with those original descriptions so essential in determining nomenclature.

One of the extremely important groups which has been too often denied our budding

scientists is that formed by the publication of museums the world over. The catalogs and series, the monographs and bulletins published by important museums are in a very real sense the foundation stones in many branches of science. And it is not only the great museums such as the British Museum, the Berlin group, the National Museum at Washington, the Peabody Museum at Cambridge, which have issued vitally important publications. The local and the special museums have issued publications both serial and monographic which become of vital importance the minute a piece of work done here demands them. You can never foretell when one of these will seem to some professor exactly the one book in the world whose absence from our shelves is fairly blocking his studies. He could not tell you himself a week before his need suddenly arises that he would ever care for such a report or catalog. But he can make his wants known without any difficulty when the demand comes, I assure you. What has seemed a fairly good library up to this morning instantly changes to a very mediocre establishment in the afternoon after a consultation of the catalog! It is a great pleasure to be able to report to you that for five years past the income of the Octavia Bates Bequest has been chiefly devoted to the purchase of museum publications, beginning with those of the British Museum. We could use a permanent fund twice as large to very good purpose in supplementing this work, which up to this time has only begun.

Museum publications are generally issued in limited numbers and at high prices. It is a serious task to secure them. But it is easy compared to the job of getting the publications of expeditions. There is a peculiar fate which attaches to the printing and editing of the scientific results of expeditions of all sorts, Usually some member publishes a popular narrative which frequently sells rather well, particularly if any notoriety or celebrity attaches to the expedition. This very quickly gets into the libraries, as witness the host of popular accounts of polar expeditions which you doubtless all know by name. Far different is the fate of the publication of the scientific results. They are inevitably the work of different men. The labor of preparation requires vastly more time for some subjects than for others. Parts of volumes appear from time to time—members of the expedition go off on other expeditions with their first work half-done or half-published. Editors change, or die. A fire in a store-room or a residence destroys another's notes—or even the specimens themselves. Years pass and the expedition's publications are still unfinished—perhaps they are never finished. Volumes remain unbound because of a missing part never issued, but still hoped for. Publishers fail and the stock is sold for paper. Governments grow weary and withdraw subventions—then vote them again. Heaven blesses a few scientific expeditions with capable members, vigilant editors, a government's purse and completion of publication within a few years. But they are few. I could tell you tale after tale of heart-breaking delays, inconsistencies, changes of forms, failures, deaths—and all involving untold trouble for the librarian who must first *get* these things and then take care of them. Altogether a difficult and perhaps a useless job, you might say.

But then—remember the momentous results of some expeditions and voyages;—yes even of some which have never been completely published! One need only recall a few names, La Perouse, The Challanger, the Beagle, —need we go on? Take but one example—The Wilkes Exploring Expedition. You recall its history, the famous controversy over the Antarctic Continent, the numerous narratives, the slow appearance of the stately folios containing the scientific results. This was the first scientific publication on a large scale of the government of these United States, and an entire evening could be spent in a most interesting way in detailing its vicissitudes. I need mention only one volume to show its importance—Dana's great work on the Zoophytes, a book so important that seventy years after its appearance it is still regarded as fundamental. But how few libraries own a copy of the original text and plates! Printed in only 200 copies, never sold, distributed solely by resolution of Congress, what chance has there been for the newer libraries to secure a copy for their clientèle? To be sure, not all expeditions

encounter such a series of accidents in publication as this of Wilkes—but as a class they present a most difficult problem. They are alike hard to get when issued, slow to appear, slower to be finished, costly and even (occasionally) not sold at all, but only given to a select few. Later, years later, the task is much harder. If I were given a round sum and told to get in three years all the important scientific expedition publications of the past hundred years—I should decline to promise success in that time—perhaps even in five years. But I can think of but few efforts so well worth attempting.

If expeditions present difficulties alike to the librarian and the scientist, what shall we say of international congresses? That they mark the progress of research in many lines is a truism. They are absolutely needed—but they too are very hard to get. In the first place, there is no good list of them—even the brief list issued about a year ago is most incomplete. Then, the congresses seldom have permanent offices and officers. They are held at irregular intervals, generally in a different place each time they meet. If one attend, he generally gets the proceedings. But very seldom does any library get a notice of the meeting in advance. Usually the papers and proceedings are published in the place where the congress meets—at Madrid one year, three years later at Washington or Moscow or Stockholm, or where you please. The publisher of course varies with each move of the congress. An attempt to place an order for subsequent issues usually fails of execution. Three or five years is a long time for any secretary to carry an order. So if some professor from Michigan goes to the geological congress at Brussels this summer, we *may* get on the mailing list—but otherwise we probably shan't—despite our efforts. The difficulty is vastly increased by the habit of European governments of giving subvention to private publishers to aid in printing reports of congresses instead of issuing them through the governmental printing office. So they may appear in the publisher's list as his own publications—or they may never be listed anywhere. It can not be denied that the hunting down of international congresses adds zest to the librarian's life—but when you are held accountable by science for the results of your hunting it ceases to be sport. Then, too, local societies and savants have a pleasing habit of offering volumes *to* the congress as a sort of testimony alike of their interest and of their own activities. These are almost never to be confused with the Report of the Congress itself—except in the minds of booksellers who manage to introduce no end of confusion into orders as a consequence. You may imagine, therefore, that international congresses are a bug-bear to library folk—a sore topic. You may also imagine my own delight in securing over one hundred and fifty reports of various international congresses on my book-buying trip last fall. Few acquisitions have given me more solid satisfaction. And yet, I suppose I have simply created more trouble for myself—every department will now demand that these reports be made absolutely complete! In the language of the street, "I can see *my* finish!" Partial success always brings its own penalty.

Who originated the idea of the "Academy"? Whoever he was, whether Plato in the groves of Academe, or some Renaissance imitator, or even the gentleman who conceived the Royal Society, he let loose on mankind an institution making for publication—if we appraise it in no higher terms. And particularly in the nineteenth century did the academy flourish in print. Here again Europe has an advantage over America, and advantage more of age than of enterprise, of geographical smallness as contrasted with continental sweep and range. Most scientists in Europe have easy access to files of academic publications, files which have been slowly accumulated with the passing years. Here we have had to work hard in the past two decades to establish half a dozen centers in which fairly complete series may be found, a process still going on and proving increasingly costly each year. But we must continue and complete it. The interests of American scholarship simply require it of us. The greater academies are now well represented at Michigan, with here and there a gap, it is true, but still with full ranks for the most part. What to do about the minor academies and societies from the whole world? That is a

vexing question to which I may refer again in a few moments. I pause merely to remark that a minor academy is minor only so long as you do not want its transactions in your own work.

And last in this array of forms of scientific publication comes the largest group of all, newest and most insistently demanded, the journals. To me the rise of the special periodical devoted to the interest of a special group is one of the most significant social phenomena of the past fifty years. Let no one here think that this tendency to periodical publication is confined to science or to the more learned groups. By no means—the brick-layer, the barber, the banker, the baker, the builder, the book-binder (to keep to one letter only) all have their journals fully as much as the biologist, the botanist, the biochemist, or even the bibliographer. And they all have to be ordered, entered, paid for, cataloged, bound, and stored. Periodical publication is the one modern form for telling the world what everybody has done and what other people think about it. We take in over twenty-two hundred journals in the University Library. A goodly number—do you say? Well, it is just about half what other libraries of our size subscribe for, and about a quarter of what the Library of Congress receives each year. Perhaps the medical faculty is satisfied with its four hundred and sixty-six journals received. But I fear no other group really has enough. Certainly that great department loosely known as the social sciences does not have at hand here anything like an adequate supply. I see no end to this modern form of publication. Every quarter I read with sadly disappointed hope the record of "Births and Deaths in the Periodical World" appearing in the *Bulletin of Bibliography*. The births always outnumber the deaths and the marriages of journals. My one consolation is my firm conviction that wood-pulp paper has a very definite limit of stability. But then I reflect that some chemist is sure to discover some process of preserving this wood-pulp mass for an indefinite period. There is no way out. Journals and transactions, reviews and proceedings we have ever with us in ever increasing numbers. These the investigator simply must have. Can he have them all at hand currently and in bound form? Obviously not, unless we multiply our library budgets about ten-fold, and our storage quarters five-fold.

This leads us very naturally to consider this problem of supplying the full record of science to our men of science. It is not a local problem merely. It is also a national problem. The difficulties in the way are partly those of finance, partly those of time, partly competition, not alone among American libraries, but with those of Japan and China, of South America and South Africa, of New Zealand and Australia. Very much of the material required by this group before me was published in but a small edition, running from a couple of hundred in the case of certain very costly books, to a thousand or more for certain journals. In their beginnings journals and transactions are frequently issued in only sufficient numbers to meet the actual number of subscribers. You all know how the waste-basket yawns for odd numbers, and what chances of destruction stray copies must run, between careless or absent-minded owners, house-maids, janitors, the frugal house-wife and the rag-man. Wars and disasters intervene to reduce the numbers of copies in existence. I have no hesitation in saying that the possibility of securing sets of certain very much valued books and journals is diminishing even to the vanishing point with each year that goes by. The world war was destructive of reserves, caused restriction in the number of copies printed, and increased enormously the cost of printed matter of all sorts. In some cases known to me no copies were printed beyond the actual home demand, totally ignoring foreign or enemy subscribers. I know of one American journal which actually printed last December one hundred and fifty copies less than its regular subscription list, because paper took a sudden jump in price and only the stock on hand was used. This sort of thing makes the task of securing sets anything but easy. The chief source of supply is the libraries of deceased professors as they come on the market—and professors who own and bind long files of journals and transactions are becoming

rarer with the high cost of living and the decreasing amount of shelf space in modern houses and apartments. The necessity of quick action can not be stressed unduly in view of the present circumstances. It is not a question any longer of waiting for a favorable opportunity. Rather are we faced with the necessity of getting what we need whenever the chance comes up. The competition from the newer countries and the newer libraries is keener every year. Thirty years ago there was no large scientific library west of us—not one. Now we may mention the Universities of Chicago, Illinois, Wisconsin, Minnesota, Iowa, Nebraska, California, Leland Stanford, Washington, and the John Crerar Library, without even exhausting the list of institutions of the first rank—for special libraries in a small field are equally dangerous competitors for the valuable books and sets in their own line. In those same thirty years South America, South Africa, Japan, Australia, and Canada have come into the field eager to provide their scientists with the record of science. McGill University bought just before me last fall very many sets of journals long on our list of desiderata. I found Japanese buyers had been everywhere with the government purse to draw on. The fact is that we must both hasten our own purchases and combine with our neighbors if American learning is to be kept on an equality with that of Europe.

The need of cooperation and of a policy looking to the elimination of certain forms of competition is brought home to me more keenly each year. We should be able, it would seem, to agree on certain fields which we can cultivate intensively, securing everything of moment in them, as far as we can raise the funds. Certain general works, general society transactions, journals of a wide appeal we must *all* have. But must we—to take a concrete case—*all* try to buy the publications of the smaller and less important societies? May not half a dozen sets spread over the country suffice with the development of the interlibrary loan and of photo-duplicating machines? Can we not agree with Chicago, Urbana, Cleveland, Columbus, Pittsburgh, and Ithaca on a limit in purchasing such local society publications? Thus we might *all* save money, keep down prices, gain in the total number of sets available, and lend freely between ourselves. This matter seems to me highly important—even vital to our success. It has been much discussed among librarians. There would be small difficulty in arriving at a policy, if it were a matter to be decided by librarians alone. But it concerns far more deeply the faculties of the various universities and their governing boards. We librarians can not, for example, get together and agree on a limitation of our several fields of specialization. We must first gain adherents to a policy of limitation, then form an agreement through some joint committee of professors, and finally secure the consent of boards of regents and trustees. The facts are most clear and patent. We simply can not all have everything. There isn't enough to go 'round, nor money enough to buy everything. What we must do, then, in common sense is to stop trying to get everything in each library, and go for the things we can reasonably expect to secure in cooperation with our neighbors. If any one doubts the success of this plan, I refer him to the results of the agreement between the Chicago libraries made in 1895 and carried out since to the lasting benefit of scholarship. There is every reason why we should enter into a similar pact with neighboring libraries.

For what is our position now? We have no near neighbors among universities. We stand half-way between Cornell and Buffalo on the east and Chicago and Northwestern on the west. Western Reserve, Ohio State and Oberlin to the south are in a manner comparable with our collections—but as yet hardly formidable rivals. There is practically nothing north of us—(Remember that I am speaking now of libraries whose chief interest is the furthering of scholarship). We have two large public libraries fairly near—Detroit and Cleveland, both owning certain valuable special collections, and both likely to specialize in technology and in the applied sciences. There are a few specialized libraries of distinction, such as that of the Western Reserve Historical Society at Cleveland, which owns what is probably the best collection on our Civil War in existence. We may safely say, then, that we have fewer neighbors on whose aid we may rely than have the eastern universities or those

in the northern Mississippi Valley. But there is no reason that I can see why we should attempt to duplicate and surpass, for example, the White Collection of Folk-lore in the Cleveland Public Library, or the Burton Collection of local history and genealogy in the Detroit Public Library. Nor should we fail to agree with the Chicago libraries and those of Ohio (and even perhaps of western New York and Ontario) as to certain fields of learning which they will leave to us, and others in which we shall not aim at more than general works. I should like to see the Association of University Professors, or some other body representing various universities, take up this problem in a practical fashion. The interlibrary loan and the photostat put the resources of each library at the disposal of its neighbors. Why neglect so obvious a step as conference and agreement on subjects of specialization? But, of course, when it comes to self-denying ordinances, only the men concerned may pass them. It is not for me to say what any group of professors shall forego. It is "up to" them in the interest of science as a whole and of its progress in our land. I can merely point out one very obvious step to be taken—and perhaps push a little towards that step.

Our present situation here at Michigan is better than it was, but it is far from satisfactory. We have a goodly list, for example, of journals and society transactions—but we have far too many gaps in the sets, gaps that are very hard to fill. We have a fair lot of expedition publications—likewise badly defective. We have a few of the great monumental publications, and very incomplete sets of congresses and museum publications. I have already indicated that our collections of monographs are reasonably large. But we are distinctly worse off in the pure sciences and the applied sciences than we are in literature or American history. We are far worse off as regards economics or philosophy than in scientific fields. We have a faculty and a student body probably third in size in America. But the library ranks about eighth among universities in number of volumes. We have, therefore, very much to add before our book collections correspond to our size in students and faculties. Harvard, for instance, has more than four times as many books as we have, Yale three times as many, and Columbia and Chicago about twice our holdings. This is a situation not to be remedied in a day—even were adequate funds in hand, as I have tried to show. All the more reason, therefore, why we should think clearly and plan wisely, and should cooperate with our neighbors.

The country as a whole is in about the same relative state as regards the record of scientific work the world over as is the University of Michigan. That is to say, by diligent effort we can find the obscure and the rare, and without too much trouble can secure the obvious and ordinary run of books. But taken as a whole, the country is decidedly worse off than most European lands. Our scientists are at a distinct disadvantage when it comes to books as compared with those of Great Britain, France or Germany, or even Italy. We can only overcome this handicap—which is very real—by the most careful bibliographic work and by lending freely.

This brings me to that aspect of our topic which was probably most in my friend's mind when he spoke so disparagingly of bibliography. Most people ignore the practical and administrative side of the bibliographer's labors. They think of him merely as one who records what other men have done and said. That he is also the gatherer of material, and to a large extent its interpreter they forget. But the major function of the scientific bibliographer is that of indexing the record of science, after he has got it together. This is a highly technical job and has been very well done in certain fields, and very poorly done in others. Perhaps medicine has the best indexes. The great catalog of the library of the Surgeon-General's Office in Washington forms one of the most remarkable pieces of index work ever attempted. The *Index Medicus* is a wonderful clue to the currently appearing work of the world of medicine. Both have proven frightfully expensive. Both are due to the energy of one man, John Shaw Billings, and the extraordinary skill and devoted patience of his associate and biographer, Fielding H. Garrison. Neither has ever paid expenses and both have had a hard struggle to survive,

despite government aid and the purse of great foundations. Even now we are threatened with a curtailment, if not the ending, of the catalog. Such books are very costly, but without them, science must perforce halt its progress.

The pure sciences have had no such American record as these two in medicine. The Royal Society's *Catalogue of Scientific Papers*, appearing years after their publication, is the most conspicuous British effort. And then, after years of incubation, came the great international undertaking known as the *International Catalog of Scientific Literature*, bearing the Royal Society's imprint and prepared by regional bureaus under an international council. This was to begin with the twentieth century and to be the final word in all branches of pure science. Now unhappily the world war has brought it to a standstill, probably to an end. But it was already breaking down of its own weight before the war. The plain speaking of the few librarians who were given any chance to be heard between 1895 and 1900 was utterly disregarded. They insisted, if I remember correctly, that without some provision for cumulation of entries at intervals of about five years the scheme would defeat its own ends. And their prophecy was amply justified before the war brought a halt to the already huge series of annual volumes. The set remains a monument to the difficulties of the task of an adequate index to the published work of scientists.

A few attempts at overcoming this difficulty by card bibliographies have been made. Of these the most conspicuous is the work of the Concilium Bibliographicum in the field of zoology, paleontology and anatomy—an undertaking which is likewise due to an American, the late H. H. Field. This is, as you doubtless know, a classified bibliography printed on cards, arranged in very minute sub-divisions of the decimal classification. When you once learn how to use it, it is most valuable. It usually takes us about a year to train a girl to file the cards, and how long it may take a zoologist or an anatomist to learn how to use them to full advantage, I can not say. This bibliography was also stopped by the war, but will soon be resumed with money supplied by the Rockefeller Foundation. I know of no other current card subject bibliography on a similar scale.

The tendency has been, on the whole, to develop special annual reviews in rather minute sub-divisions of the general field. Of these by far the most conspicuous have been the *Jahresberichte* appearing in Germany. There was formerly no end to these special bibliographies—often accompanied by critical notes on the scope or value of the works listed. They, too, were mostly stopped or curtailed by the war, and various efforts have been made to revive them or produce new ones. You each know your own favorite bibliographical review—but do you know the difficulties under which they have labored and which are well-nigh fatal at the present day? The chaotic condition of the world from an economic or political viewpoint is well matched as regards the record of science. Publication of results is still slow and defective—indexing of publications is more so. The obligation rests on America to provide both the means of publication and the proper clue to recorded work. I can hardly stress this too strongly, as I necessarily am forced to take a broad and general view of the whole situation. If the needed indexing of scientific (and indeed all learned) literature is to be done at all—it must be financed in this country. I can think of nothing more important for the attention of the American Association for the Advancement of Science than this very problem of adequate successors to those special and general indexes which have been so useful and which are now either suspended or definitely dead.

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May I, as a layman, venture a suggestion to you who are experts? I feel that most of you tend to ignore in the organization of your work of instruction any presentation of two things which help to mark a scientist of real distinction. The first of these is a knowledge of how to use to the full the various bibliographic tools provided. It seems to me that such instruction in their use is a real necessity—perhaps not for elementary classes, but certainly for any study of an advanced character.

The loss which comes from an ignorance of what has been done on any given problem is pathetic—loss of time, unnecessary labor, discouragement. It is a loss which can be avoided by very simple means. The gain which comes with full knowledge of previously published results is uncounted. It marks the successful from the halting start on any task. The complexity of the bibliographic indexing in most fields is so great that there is real need for formal instruction in handling bibliographic tools. No one of you ignores instruction in laboratory method. Should he overlook the need of instruction in bibliographic method? The second of my two marks of distinction is a broad, general view of the history, methods and scope of his subject, what in my youth the Germans used to call "Encyclopædie." Few men are willing to take the time from their own particular researches to lecture on a general introduction to their subjects. But I venture to point out that precisely such a broad, sweeping view of the whole topic is what the younger men need most. It can be given only by one whose reading has been wide, whose grasp of the whole subject is firm, whose judgment is matured, and whose experience entitles him to speak with authority. What in a master makes disciples? What qualities in some men enable them to found a real school? Is it not precisely that grasp of method, that sense of relations of parts to the whole, that historic view and that prophetic insight which comes from a deliberate attempt to survey the whole of one's subject, to weigh its importance, to contemplate not alone its past but its present and future? My suggestion is that students should not be left to pick up either bibliographic method or a general view of their subject from incidental allusion or chance comment. The need of both is too great and too serious to warrant the indifference or neglect which they now seem to encounter.

To sum up, then, this attempt at some reflection on the record of scientific inquiry, particularly as it concerns us at the present hour and in this university: We have made a fair beginning at providing our men and women with the printed record of the more immediate past. We have at least the rudiments of a good collection of the important work of the remoter periods. We know rather precisely the direction which our efforts in buying should take, and more than a little as to the difficulties in our path. We are ready to do our part (I take it) in any cooperative scheme for furnishing to this Great Lakes region a fuller measure of books and journals. We know the imperfections of our bibliographic tools. (We have most of them in constant use!) And we stand ready to contribute in this field also our own share of cooperative labor. In other words—we know our defects and we are trying to overcome them, and all we need is time and money—and perhaps wisdom!

What of the future? What may we hope for in twenty years, supposing no great disaster checks our labors?

We may, I believe, expect to find here (available to a large region) the major academic and society publications in absolute completeness. We may further expect at least double the present amount of journals, both current numbers and bound files. We shall be part of a regional group of libraries, owning our share of the minor society publications and journals, with a fairly complete whole ready for rapid use, distributed by air-mail in response to wireless telephone requests, every few hours. It ought not to take a man here in 1930 any longer to get a book from Columbus or Chicago than it now takes him in many European libraries—that is, six to twenty-four hours. We shall have a completed printed list, kept up to date, of all the periodicals and transactions (and perhaps all the books) available both in the libraries of our region and the whole United States. (This is almost in sight now! With two hundred thousand dollars it could be done in two years' time!) We should have also a bibliographic equipment which will furnish with the minimum of effort a practically complete list of all articles and books on any topic, arranged in inverse chronological order, the latest to appear coming first. This is solely a matter of organization and money. It represents merely the marshalling of a sufficient number of trained people to supplement work already begun on methods already worked out. It means ap-

plying the method of storing linotype bars and using them as needed, for example, in the cumulation decade by decade of the Royal Society's International Catalog. This work could be organized for the future in three years and printing of the first two decades of the twentieth century finished in five or less. I am less sure that it will come than I am confident of the future provision in the way of books. But if and when the key to the record does exist, then no budding scientist may fail of confidence in his start, of the help in his labors as they go on year by year which comes from knowing what has been done and what is being done by his fellows. We shall have them ready at hand—not alone the record in print of human efforts to comprehend the universe, but also such an effective and useful key to that record that we may reverse the old saying, and affirm he who reads may run.

WM. WARNER BISHOP

MAY 26, 1922

THE DEPLETION OF SOILS BY CHEMICAL DENUDATION

THE rate of chemical denudation of soil and rock material has been of vital interest to geologists and soil scientists. The geologist has been interested in an attempt to establish a unit of time for estimating the age of the ocean, the time periods of geologic processes and incidently the time periods of the life of man, animals and other forms of life on the globe. He has been ably assisted by hydrographers and oceanographers. The soil scientist has been interested in relation to time measurements of soil productivity and of methods to be taken to prolong the life and the endurance of the soil for the agricultural needs of the people.

Unfortunately the vast amount of information that has been collected has been based mainly upon the translocation of material in true solution, disregarding all material in colloidal solution. The results of the methods used have shown surprisingly little silica, alumina and iron lost from the soil in comparison, for instance, with the amount of potash lost. In fact, the soil scientists have assumed that the three first named elements, which form by far the larger proportion of the soil, remain in the soil because of their slight solubility. There has been a lack of evidence of any considerable loss of these through solution.

The hydrographers have determined, from the average composition of the soluble salts carried to the sea, that SiO_2 constitutes 8.60 per cent., Al_2O_3 and Fe_2O_3 together constitute 0.64 per cent. and K_2O 2.13 per cent. This gives a ratio of one part of potash to 4.4 parts of silica, alumina and iron. As the ratio of potash to silica, alumina and iron in igneous and in shale rocks is about 1 : 25, there is an apparent selective loss of potash; that is, the loss of potash is relatively much greater than the loss of the main soil constituents. From this fact, together with the fact that plants appear to have the same selective power of absorption of potash in much greater proportion than of the original proportion of the main soil constituents, soil scientists have taken a very pessimistic view of the length of time the soil will remain fit for agricultural use.

Opinions have been advanced by some that our most productive soils will only last for one hundred and fifty years or so without replacement, because of this selective loss of plant food material due to their greater solubility and assuming further that the silica, alumina and iron are removed in very small proportions from the soil because of their relative insolubility. Such is briefly an outline of the situation up to a short time ago.

If silica, alumina and iron are removed from the soil in proportion to the loss of the so-called more soluble salts the losses could not be determined by chemical analysis any more than the removal of a cartload of soil would affect the chemical composition of the material that remains. Recent investigations of the soil colloids by this bureau suggest that this may be actually what takes place. It would appear that, in the breaking down of the silicates to a point where the potash goes into solution, silica, alumina and iron also go into solution in the same proportion as they bear to the potash content in the original material. There is, however, this very important difference which has not heretofore been recognized or properly appreciated and that is that the solution of

silica, alumina and iron is a colloidal solution as distinguished from the true solution of the so-called soluble elements.

The methods devised for separating colloids from soils for analysis and study, and the methods for the determination of the amount of colloids in soils have apparently opened up a new and vast field of research, the results of which will undoubtedly throw a broader light upon the subject of chemical denudation.

In my paper on "The Origin of Soil Colloids and Reason for the Existence of This State of Matter," published in SCIENCE, December 30, 1921, I called attention to the fact that in the mechanical analysis of soils under microscopical control practically the smallest particle of matter is .0001 mm. I advanced the opinion that complex silicates of such small diameters contain relatively so few molecules that when brought into contact with water the bombardment of the water molecules shatters the mineral particles, the electrolytes going into true solution and the silica, alumina and iron going into colloidal solution, the colloids thus formed reabsorbing much or all of the electrolytes, which puts these electrolytes themselves in large part into a colloidal state.

It is difficult to conceive how the electrolytes can be dissolved out of silicates at ordinary temperatures and pressures without conceiving that the whole thing breaks down into a dissolved mass. In fact, direct evidence of this is to be found in the dry grinding of silicates in the ball mill. If this fine ground material is brought into contact with water, soluble salts go into solution as determined by conductivity or chemical test, and at the same time there is released a relatively large amount of colloidal material. What the exact ratio is between the potash, for example, which has been released from the silicate rock, and the silica, alumina and iron in the resulting colloids formed has not been determined.

Soil colloids in suspension of a gram to the liter give the appearance under the ultra microscope of minute droplets immiscible with the surrounding water capable of indefinite suspension. In larger concentrations the droplets appear to coalesce, forming a jelly-like mass which settles to the bottom of the vessel. These soil colloids have a distribution equilibrium, however, between the colloid and the surrounding water, involving silica, potash and other electrolytes to a notable extent, but affecting the iron and alumina only to an inconsiderable extent.

We have a general idea of this distribution equivalent in the case of analyses which have been made of the truly soluble material that passes through the Pasteur-Chamberlain filter in comparison with the colloidal material which remains on the outside of the filter tubes. The colloidal material of the Miami silty clay loam soil collected on the outside of the tubes on a strictly water-free basis carries 54.15 per cent. SiO_2, 28.03 per cent. Al_2O_3 and 13.39 per cent. Fe_2O_3. These together add up 95.57 per cent. of colloidal material. The content of K_2O is 2.89 per cent., giving a ratio of potash to silica, alumina and iron of 1 : 33. In the dissolved salts which have passed through the filter tube there is 10.4 per cent. SiO_2, 2.9 per cent. Al_2O_3 and Fe_2O_3, making 13.3 per cent., while the K_2O content is 8.1 per cent., giving a ratio of 1 : 1.6. The salts of the river waters of the United States contain on the average 8.60 per cent. of SiO_2, .64 per cent. of Al_2O_3 and Fe_2O_3, making a total of 9.24 per cent., while the K_2O content is 2.13 per cent., giving a ratio of 1 : 4.4.

The average analysis of igneous rocks as given by Washington on a strictly water-free basis shows 60.14 per cent. of SiO_2, 16.32 per cent. of Al_2O_3 and 7.84 per cent. of Fe_2O_3 and FeO calculated to Fe_2O_3. This makes 84.30 per cent., while the K_2O content is 3.27 per cent. This gives a ratio of potash to silica, alumina and iron of 1 : 25.8, as compared with the ratio of 1 : 33 in the case of the Miami soil colloid as above. The composition and ratio of potash to silica, alumina and iron in shale rocks is nearly identical with the igneous rocks.

The average composition of deep marine sediments ("red clay") on a water-free basis, excluding sea salts and shells, shows according to Steiger 54.48 per cent. SiO_2, 17.15 per cent. Al_2O_3 and 10.36 per cent. of Fe_2O_3 and FeO calculated to Fe_2O_3. This makes a total of 81.99 per cent., while the K_2O content is 3.07

per cent. This gives a ratio of potash to silica, alumina and iron of 1 : 26.7 or very nearly the ratio in the igneous rocks. The "terrigenous clay" of the deep marine sediments has a rather larger content of SiO_2 and a somewhat smaller content of K_2O, giving a ratio of 1 : 36.4.

The average composition of the soil colloids shows somewhat less SiO_2 than is contained in igneous rocks but considerably more Al_2O_3 and Fe_2O_3, indicating probably that much of the quartz from the disintegrating rock remains as such in the soil. On the other hand, it is seen that the marine sediments have gained in SiO_2 over the soil colloid for which we can offer at present no explanation.

An examination of the Miami silty clay loam soil shows the following very interesting figures. If we assume a weight of 3,500,000 pounds per acre foot, the composition on a water-free basis with 81.11 per cent. of SiO_2 shows 2,838,850 pounds of SiO_2 per acre; Al_2O_3 at 10.46 per cent. gives 366,100 pounds per acre; Fe_2O_3 at 2.80 per cent. gives 98,000 pounds per acre, while K_2O at 2.27 per cent. gives 79,450 pounds per acre. The amount of soil colloid at 19.3 per cent. gives 675,500 pounds of colloid per acre foot. The SiO_2 content of this colloid amounts to 365,780 pounds, the Al_2O_3 189,340 pounds, and the Fe_2O_3 90,449 pounds, while the K_2O content of the colloid is 19,522 pounds per acre.

The total soluble salts of the Miami silty clay loam soil collected after passing through the Pasteur-Chamberlain filter, after treatment of one part of soil to five parts of water, amounts to 60 parts per million of the soil. The SiO_2 in soluble form in this soil collected under these conditions is therefore 22.43 pounds per acre and the Al_2O_3 and Fe_2O_3 6.16 pounds, while the K_2O is 27.16 pounds per acre.

This bureau has determined from observation of river waters the presence of colloidal material but has made no analysis to determine the amount or composition of this colloid. Unfortunately, in all of the river analyses that have been made the amount of silica, alumina and iron in colloidal solution owing to the lack of methods has not been determined and has not been included in the evidence presented of chemical denudation. It seems likely that the colloids carried by the rivers approximate in composition the soil colloid and arguing from the figures above given pertaining to the Miami silty clay loam soil the 2.13 per cent. of K_2O and the 9.24 per cent. of silica, alumina and iron as reported for the average river water gives only one part of the story. If the ratio of 1 : 1.6 of potash to silica, alumina and iron of the soluble salts is changed to the ratio of 1 : 33 as in the colloidal solution, then in addition to the soluble potash, silica, alumina and iron as reported in the river water analyses, we will have a colloidal solution carrying, in its dry parts, 2.89 per cent. of potash, 54.15 per cent. SiO_2, 28.03 per cent. Al_2O_3 and 13.39 per cent. Fe_2O_3.

The total additional amount of potash in the colloidal matter carried by the rivers, as compared with the total amount of potash in true solution, and the total amounts of SiO_2, Al_2O_3 and Fe_2O_3 carried in this colloidal matter, as compared with the amounts carried in true solution, can not be determined without further investigations and further determinations of the material carried by the river water. If we knew the amount of soluble material in the river water, the amount of colloidally dissolved material and the amount of unaltered rock fragments there would still be one item which would make comparison difficult and would be seemingly difficult to evaluate, and that is the amount of CO_2 that enters from the air and from decomposing organic matter, which would combine with some of the constituents noticeably with lime, either in the soil or in the river water. It seems likely, however, from the consideration of the facts given that this would be a small factor.

Until we evaluate all these factors and particularly until we determine the actual loss through chemical denudation of silica, alumina, iron, potash and other electrolytes in the colloidal state carried by the rivers, we are in no position to even speculate as to whether chemical erosion is a selective process which might change the chemical composition of the soil or whether materials leave the soil in about their original ratios which would not change materially the chemical composition of the soil upon which water has acted.

MILTON WHITNEY
BUREAU OF SOILS,
U. S. DEPT. OF AGRICULTURE,
WASHINGTON, D. C.

SCIENTIFIC EVENTS

THE PITTSBURGH MEETING OF THE AMERICAN CHEMICAL SOCIETY

(American Chemical Society News Service)

FROM an industrial standpoint the meeting of the American Chemical Society in Pittsburgh from September 4 to 8 will be one of the most important scientific gatherings ever held in this country. It will be of particular interest and value to the automobile industry. Among the important inventions which will be publicly described for the first time is a new zinc oxide, much smaller in particle size than any zinc oxide heretofore made, the work of Frank G. Breyer, chief of research for a New Jersey zinc concern. This pigment used in the tread of automobile tires gives almost twice the wear of tires containing ordinary zinc oxide.

Dr. Thomas Midgley, Jr., and T. A. Boyd, of Dayton, Ohio, will give a demonstration in Carnegie Hall of how various fuels detonate and explain how "knocking" may be reduced by the use of various compounds. Their work is of great importance, inasmuch as it probably will be the basis, in the future, of building automobiles of much greater power and increased efficiency in the use of fuel.

Nearly all the sixty-four local sections of the society, located in nearly all the states, will be represented at the meeting. From 1,500 to 2,000 chemists are expected to attend.

Dr. Charles L. Parsons, secretary of the society, who has just returned from Europe, where he attended the International Conference of Pure and Applied Chemistry, held at Lyons, France, the last week in June, says that European scientists are watching American research work with great interest, but that very few, if any, will attend the Pittsburgh meeting, as economic conditions, particularly on the continent, make it almost impossible for European chemists to travel. They, however, are keeping in close touch with Americal chemical progress through the literature of the society.

As an instance of the respect of European chemists for American procedure and methods, Dr. Parsons pointed out that the Commission on Nomenclature of Mineral Chemicals decided that the "Formula Index" printed in *Chemical Abstracts*, one of the publications of the American Chemical Society, be the standard for scientific purposes the world over. Likewise, the abbreviations used in *Chemical Abstracts* were adopted as the standard by the Commission on Chemical Periodicals.

The chief address of the Pittsburgh meeting will be by Dr. Edwin E. Slosson, author of "Creative Chemistry," on "The constructive chemist." Dr. Slosson, who was for many years literary editor of *The Independent*, is now editor of *Science Service*, Washington.

Information received by the American Chemical Society indicates a tremendous increase, since the war, of interest in chemistry as a result of the work being done to explain in "every-day" language some of the achievements of this science. These results seem to be directly due to efforts of Dr. Edgar F. Smith, president of the society, to get American chemists to speak before clubs of men and women, social and business, throughout the country, and through the writings of such men as Dr. Slosson, Ellwood Hendrick, of New York, and others.

At the Pittsburgh meeting further steps to advance improved methods of teaching chemistry, from the high schools up, will be taken by the Section of Chemical Education, of which Dr. Smith is chairman.

EXHIBIT OF OPTICAL INSTRUMENTS

ARRANGEMENTS are now being completed for the exhibit of optical instruments and apparatus to be held at the National Bureau of Standards, Washington, in connection with the annual meeting of the Optical Society of America, October 26 to 28, 1922.

The leading manufacturers of optical equipment have already signified their intention of participating. However, the exhibit will not be limited to standard commercial types. Individuals and research laboratories are also invited to exhibit special research apparatus. Brief descriptions of instruments and their purposes supplied by the exhibitors will be printed in the program and published later in the minutes of the meeting in the *Journal* of the Optical Society. The exhibit of new apparatus will thus constitute just as definite a

contribution to science as a paper communicated to the meeting. The authors of papers communicated at this meeting are urged to supplement their papers by an exhibit of apparatus in case such an exhibit is suitable and practicable.

Exhibitors are urged to prepare their exhibits and descriptions so as to give them the maximum educational value.

Exhibits must be listed with the committee at the Bureau of Standards not later than September 20. Blank entry forms for this purpose may be obtained from Professor C. A. Skinner, chairman, Exhibit Committee, O. S. A., Bureau of Standards, Washington, D. C. Exhibits may be installed from October 24 to 25 and installation should be completed not later than noon, October 26.

IRWIN G. PRIEST,
Secretary

VENTILATING CODE OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

THE code for the ventilation of public and semi-public buildings adopted by the American Society of Heating and Ventilating Engineers in 1915 has been submitted to the American Engineering Standards Committee for approval as the American standard.

This code was prepared by a committee of the American Society of Heating and Ventilating Engineers in response to requests from state commissions, legislative bodies, public health agencies and other organizations for suggestions to be used in the preparation of legislation and regulations regarding the heating and ventilation of buildings. The committee endeavored in this code to cover the general features most essential to the public health, in such a manner as to protect the public with the least possible expenditure for equipment and without unnecessarily limiting the methods of obtaining the desired results.

Section 1 of the code relates to general matters pertaining to all classes of buildings; the remaining three sections relate to schools and colleges, factories, and theaters, respectively.

Among the states that have utilized parts of the code in their regulations are: Illinois, Indiana, Kansas, Massachusetts, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Utah, Virginia and Wisconsin. A thoroughly representative special committee, including all the important organizations interested in the subject, has been appointed by the American Engineering Standards Committee to investigate the status of the code in the industry and the desirability of approving it. Sidney J. Williams, chief engineer of the National Safety Council, is chairman of this special committee.

The American Engineering Standards Committee would be glad to learn from those interested of the extent to which they make use of this code, and to receive any other information regarding the code in meeting the needs of the industry.

THE AQUARIUM OF THE ZOOLOGICAL SOCIETY OF LONDON

WE learn from *Nature* that the Council of the Zoological Society of London has approved a scheme for the establishment of an aquarium at the Zoological Gardens in Regent's Park. The aquarium is to be built under the Mappin Terraces, but so installed as to be invisible from the front, and will not interfere with the panorama of the terraces. It will consist of a crescentic gallery, 400 feet long, lined with tanks on both sides. Those on the outer curve will have both daylight and electric illumination, while those on the inner curve will be lighted by electricity only, a method used at the Berlin Aquarium with complete success. The gallery will be divided into three parts—fresh water, marine, and tropical aquaria—with special ponds for seals, diving birds, and trout. The tanks are to be constructed with the bottoms, sides and backs of slate, and the fronts of polished plate glass set in a framework of white marble. They will be provided with rock-work arranged to suit the needs of their inhabitants. The water will be kept constantly circulating, flowing into the tanks from high-level reservoirs and thence through a series of underground filter-beds, on the plan of those in use at the New York Aquarium, to low-level reservoirs, from which it will be pumped by electric pumps to the high-level reservoirs again. Special arrangements are to be installed for heating the tanks and for regulating the

temperature of the water in the different aquaria. The plans for the gallery have been prepared by Messrs. Belcher and Joass, and the circulation, electric plant, and the heating, lighting and ventilating systems have been designed by Sir Alexander Gibb. The scheme will cost about £50,000, and should provide London with the best-equipped and most carefully arranged aquarium in Europe.

SCIENTIFIC NOTES AND NEWS

AT the forty-first annual meeting of the Society of Chemical Industry, held in Glasgow in July, Professor R. F. Ruttan, of McGill University, presided, and made an address on "Some aspects of industrial and scientific research." Professor H. E. Armstrong, of London, gave the first of the Messel Memorial lectures.

MR. CALVIN W. RICE, secretary of the American Society of Mechanical Engineers, sailed from New York on August 23, to represent the engineers of the United States at the Engineering Congress to be held in connection with the International Exposition at Rio de Janeiro. A dinner in his honor was given at the Engineers Club on the evening of August 21.

DR. HENRY S. DRINKER, formerly president of Lehigh University, has been appointed the successor of the late Joseph T. Rothrock as a commissioner of forestry in Pennsylvania.

MR. C. A. SUSSMILCH, principal of the Newcastle Technical College (N. S. W.), and formerly lecturer in charge of the department of geology and mining, Sydney Technical College, has been elected president of the Royal Society of New South Wales.

THE Royal Dutch Institute of Engineers has appointed as honorary members Sir Charles Parsons, inventor of the Parsons steam turbine, Mr. J. H. Tudsbery, secretary of the Institution of Civil Engineers, London, and Mr. Charles le Maistre, secretary of the International Electro-Technical Commission in London.

THE seventieth birthday of Dr. S. Goldflam, the Polish neurologist and alienist, has been celebrated, a special volume of "Neurologie polonaise" being dedicated to him.

DR. REID HUNT, of the Harvard Medical School, Boston, has been elected on the editorial board of *Physiological Reviews* for 1922.

At the recent meeting of the International Union of Pure and Applied Chemistry, as has already been noted, Sir William J. Pope was elected president of the union, and it was decided that the next meeting should be held in Cambridge, England, on June 17, 1923. Dr. Wilder D. Bancroft, professor of physical chemistry at Cornell University, was elected vice-president for America, succeeding Dr. Charles L. Parsons, secretary of the American Chemical Society, whose three-year term of office has just closed.

ON May 24, a Hawaiian Section of the American Chemical Society was organized with the following officers: C. C. James, *chairman;* S. S. Peck, *vice chairman;* R. Q. Smith, *secretary;* Guy R. Stewart, *treasurer;* Frank T. Dillingham, *councilor.*

AT the convention of the Western Psychological Association held at Stanford University on August 4 and 5, the following officers were elected: *President,* Edward C. Tolman, of the University of California; *vice-president,* J. Edgar Coover, of Stanford University; *secretary,* Edmund S. Conklin, of the University of Oregon.

DR. ELWOOD MEAD, professor of rural institutions, University of California, has been made an honorary member of the American Society of Agricultural Engineers. Dr. Mead recently returned from the Hawaiian Islands, where he went on the invitation of the Hawaiian Home Commission to investigate conditions on the islands.

DR. W. W. COBLENTZ, physicist of the National Bureau of Standards, spent part of the month of June at the Lowell Observatory extending his radiometric investigations of last year at Flagstaff, on the stars and the planets. The observing conditions were favorable and progress was made both in the accumulation of new observational data and in tests of new apparatus. The observations were carried out with the 40-inch reflector.

DR. WM. F. PROUTY, of the department of geology of the University of North Carolina, has accepted a part time engagement as paleontologist for the West Virginia Geological Survey, in the study and description of the fossil faunas of the Devonian, Silurian, Ordovician and older beds of that state. Dr. Prouty is spending the summer vacations in the field making collections and stratigraphic studies. For the present year his work will be in Mercer, Monroe and Summers counties in connection with Mr. David B. Reger, assistant geologist, in the latter's studies of the geology of this area. Dr. John L. Tilton's paleontologic work for the West Virginia Geological Survey will be confined principally to the study of the fossil fauna and flora of the Monongahela and Dunkard beds of the state.

M. T. JENKINS, of the U. S. Department of Agriculture, has been detailed to the Agricultural Experiment Station of Iowa State College for cereal breeding experiments on the relative value of the pure line theory of selecting new varieties of corn.

UNDER the direction of Professor Clifford H. Farr, of the botany department of the University of Iowa, the city officials and residents have cooperated in a campaign to rid the city of ragweed for the eradication of hay-fever.

DR. DONALD D. VAN SLYKE, of the Rockefeller Institute, is on his way to China, where he will participate in teaching, for six months, at the Medical School at Pekin.

DR. LOUIS A. BAUER gave a lecture on the "Earth's magnetism and electricity" before the Royal Society of Western Australia, at Perth on June 21, as also before the Philosophical Society at Wellington, New Zealand, on July 5. During an inspection trip to the Carnegie Institution Magnetic Observatory at Watheroo, Western Australia, he completed arrangements for continuous earth-current observations. This observatory will be the only one completely equipped in the southern hemisphere for investigations relating to the earth's magnetism, atmospheric electricity, and the earth's electric currents. While in Australia he furthermore made arrangements for special magnetic and electric observations at various stations during the solar eclipse of September 21, 1922. At Wellington Dr. Bauer attended a specially-called meeting on July 4 and 5 of the Samoa Observatory Honorary Board of Advice. Arrangements were perfected for further cooperation in the maintenance of the Samoa Observatory at Apia by New Zealand, the British Admiralty and the Carnegie Institution of Washington. Dr. Bauer returned to Washington the middle of August.

As has been noted here, Professor Santiago Ramón y Cajal, having reached the age limit, has retired as incumbent of the chair of normal histology and pathology of the Madrid Medical School. The *Journal* of the American Medical Association says: "The whole country has rendered tribute to the great scientist, bestowing on him every distinction and honor, the greatest, perhaps, being the award of the Echegaray medal. This was presented to him in the Royal Academy of Sciences by the king, who delivered a speech overflowing with respect and love for the illustrious Spaniard, who has brought so much prestige to his country. A number of cities have designated Ramón y Cajal as their adopted son; many others have named streets after him, and prizes have been established in his name. The government performed an act of greater importance in introducing a bill for the construction of a building for the Cajal Institute, which was organized February 20, 1920. The bill carries an appropriation of a million pesetas ($155,400), divided into four sums which will be spent annually from 1922 to 1925 on the building designated as Cajal's Biologic Institute. An appropriation of 50,000 pesetas ($7,770) a year is made for maintenance, including the 10,000 pesetas ($1,540) now provided for Cajal's laboratory. The work of the institute will be directed by a board of trustees presided over by Cajal."

PROFESSOR H. J. HAMBURGER, the distinguished physiologist of the University of Groningen, Holland, will give the first series of Charles E. Dohme Memorial lectures at the Johns Hopkins Medical School on October 10, 11 and 12. This lectureship has recently been established by Mrs. Charles E. Dohme as a memorial to her husband, the late Charles E.

Dohme, a well-known manufacturer of pharmaceutical products. It is the purpose of the donor to have presented in these lectures discoveries which intimately concern the fields of chemistry, pharmacy and medicine. Professor Hamburger has chosen for the title of his lectures, "The increasing significance of permeability problems in physiology and pathology."

PROFESSOR ALBERT PERRY BRIGHAM, of Colgate University, gave a course of lectures on "The American Domain and the American People" before the Oxford University School of Geography from August 10 to 16.

ROLLIN D. SALISBURY, since 1892 professor of geographical geology and since 1897 dean of the Ogden School of Science at the University of Chicago, died on August 15, aged sixty-four years.

EDWARD M. EIDHEER, formerly expert in the department of agriculture, bureau of chemistry, Austria, member of the Academy of Science of Vienna, died on July 24, aged sixty years.

STEPHENSON PERCY SMITH, known for his work on Polynesian ethnology, has died at New Plymouth, New Zealand, at the age of seventy-two years.

ACCORDING to the regulations of the "Van't Hoff Fund" founded in 1913, the foundation in Amsterdam under the supervision of the Royal Academy of Sciences appropriates annually allotments to investigators in the field of pure and applied chemistry. The amount available for 1923 is about twelve hundred Dutch florins. The committee in charge consists of A. F. Holleman, *president;* S. Hoogewerff, A. Smits and J. P. Wibaut, *secretary.*

THE seventh summer meeting of the Mathematical Association of America will be held at the University of Rochester, Rochester, New York, on Wednesday and Thursday morning, September 6 and 7. The American Mathematical Society will meet in Rochester on Thursday afternoon and Friday, September 7 and 8. A joint dinner will be held on Thursday evening at the Oak Hill Country Club, the future site of the university. Professor R. C. Archibald, the president of the association, has been invited to give a report at this time on European conditions, based on his six months' traveling in Europe. The sessions of the association on Wednesday will be held in the Eastman Building, at 10 A.M. and 2 P.M. The session on Thursday morning will be held at 9:30 A.M. at the Research Laboratory of the Eastman Kodak Company. A short chamber concert will be given for the members of the association and the society in Kilbourn Hall, of the New Eastman School of Music, at 4:30 P.M. on Wednesday. An automobile ride on Thursday afternoon will precede the joint dinner.

THE autumn meeting of the British Iron and Steel Institute will be held at York on September 5 to 8, when it is expected that ten papers will be submitted for discussion. In addition to an excursion to Rievaulx Abbey and Castle Howard, visits have been arranged, with special trains, to the works of the Staveley Coal and Iron Company, near Chesterfield, and of the Parkgate Iron and Steel Company at Rotherham.

IN connection with the National Colonial Exhibition to be held in September at Marseilles, a "Semaine Internationale" has been organized for the purpose of bringing together geographers, explorers, ethnologists and naturalists, whether French or of other nations, who are in sympathy with French colonial achievements. The program will include visits under suitable guidance to the exhibition galleries, public lectures and technical meetings, social functions and geographical excursions, and the congress, which is presided over by Prince Bonaparte, will last from the twenty-second to the twenty-eighth of September. The charge for tickets of membership is 25 francs, and those attending will be able to travel for half-fares on the system of the Paris-Lyon-Mediterranean Railway.

THE Imperial Department of Agriculture for the West Indies has been amalgamated with the West Indian Agricultural College, and the head office of the department has been transferred from Barbados to Trinidad.

THE London Chemical Society has agreed to supply copies of the *Annual Reports on the*

Progress of Chemistry, Vol. XIX, to members of the American Chemical Society at a reduced rate. Any member can obtain a copy of the 1922 *Annual Reports* by sending his order, accompanied by a remittance of seven shillings, to S. E. Carr, assistant secretary, Chemical Society, Burlington House, Piccadilly, London, W. 1, England. All orders must be in by January 1, 1923, as it is necessary for the society to know the number of copies desired in advance of publication. Each applicant should make known the fact that he is a member of the American Chemical Society.

WE learn from the *Experiment Station Record* that a scientific commission has been appointed by the French government to study the agricultural possibilities of French Nigeria, especially that portion lying between Bamoko and Timbuctoo. The construction of a huge dam in this vicinity is contemplated for the irrigation of the Upper Niger Valley. A general agricultural reconnaissance will be made by the commission, with special emphasis on cotton, covering a period of from twelve to eighteen months. Dr. R. H. Forbes, formerly of the Arizona University and Station and who has just concluded his engagement with the Société Sultanienne d'Agriculture of Egypt, has accepted an appointment as agronomist on this commission.

AN additional appropriation of $15,000, with legislation to guarantee its effective expenditure, will be asked of the next legislature by the Minnesota State Board of Health, for the supervision of the state tourist camps. The importance of extreme care in sanitation matters among tourists is shown in a report covering the period from 1913 to 1921, showing that 365 cases of typhoid fever in Minnesota were contracted outside the state while the victims were on vacation trips.

THE valuable collection of books on forestry, photographs, slides and papers gathered by the late Dr. Joseph T. Rothrock, the "Father of Pennsylvania Forestry," has been given to the State Department of Forestry, in accordance with a wish expressed by the former commissioner. The collection was turned over to Dr. Joseph S. Illick, chief of the research division, who worked under Dr. Rothrock, and he is arranging them to be placed in the departmental library. Among the books is a copy of Gray's Botany, which Dr. Rothrock carried with him during his service in the Civil War. Some of the photographs in the collection were among the first taken by Dr. Rothrock when he was arousing public interest in conservation and bringing about the organization of the Department of Forestry.

THE state legislature of South Carolina has appropriated $50,000 for experimental work, about half to be expended at the college and the remainder at the substations and for cooperative experimental work on different soil types in the state.

THE University of California announces that its students have won two of the four prizes offered by the Glass Containers' Association in a national competition for the most valuable paper on canning or any feature relating to canning or preserving. The first prize was won by Lal Singh, a Hindu student who graduated from the College of Agriculture with the class of 1921. His paper on "Factors concerned in manufacturing fruit products" is said to be a distinct contribution to the knowledge of jams and jellies. The paper is to be published as a series of articles in the trade magazine, *Canning Age*. J. R. Herman, a graduate student in the College of Agriculture, won the third prize in the national competition with a paper on "The utilization of grape products." The second and fourth prizes went to students in eastern universities.

WE learn from *Nature* that the Ramsay Memorial Fellowship trustees have made the following awards: Ramsay Fellowship of the value of £300 tenable for one year, but renewable for a second year, to Dr. R. W. Lunt, of the University of Liverpool, and of University College, London, for the continuation of his work at University College, London, on chemical effects of electromagnetic waves over the frequency range, 10^5-10^8 cycles; Glasgow Ramsay Fellowship of £300 to Mr. J. A. Mair, of the University of Glasgow, who will continue his research on the chemistry of the terpenes; a special fellowship of £300 for one year to Mr. W. Davies, who has already held a Ramsay Fellowship for two sessions and

whose work, especially that on the preparation of synthetic reagents from the toluic acids, shows special promise; Danish Ramsay Fellowship to Mr. Kristian Höejendahl, of the University of Copenhagen, who will pursue his research in the University of Liverpool; two Swedish Ramsay Fellowships, to Dr. J. O. G. Lublin and Mr. A. W. Bernton; and two Norwegian Ramsay Fellowships to Mr. Dag Nickelson, who will work at the Imperial College of Science and Technology, and Miss Milda Prytz, who will work at University College, London. A special Ramsay Fellowship of the value of £350, which was placed at the disposal of the National Research Council of the United States of America, has been awarded to Dr. C. S. Piggot, of Baltimore, who will begin work at University College, London, in October.

UNIVERSITY AND EDUCATIONAL NOTES

AT the University of Missouri plans have been practically completed for the new agricultural building for which $200,000 was appropriated by the last legislature. The building will constitute the center of the agricultural group, including the present agricultural and horticultural buildings, and will serve as the administration headquarters of the college of agriculture.

PROFESSOR M. JULES TISSOT, of the Paris Museum of Natural History, and Mme. Tissot have given 844,483 francs to the museum to endow the chair of physiology.

DR. CHARLES C. BASS has been elected dean of the school of medicine of Tulane University.

DR. H. H. LANE, for fourteen years professor of zoology at Oklahoma University, has been appointed head of the department of zoology at the University of Kansas. He succeeded Dr. B. M. Allen, who has gone to the Southern Branch of the University of California.

DR. WALDO SHUMWAY, assistant professor of biology at Dartmouth College, has been appointed associate professor of zoology at the University of Illinois.

DR. M. KHARASCH, who has held a National Research fellowship at the University of Chicago for the past three years, has been appointed associate professor of organic chemistry at the University of Maryland.

W. T. CHAMBERS, graduate student in the department of geography of the University of Chicago, has been appointed to a newly established instructorship in geography at the University of Tennessee.

MISS MARION BELL has been appointed biochemist in pediatrics and child welfare research at the University of Iowa.

PROFESSOR D. THODAY, of the University of Cape Town, has been appointed to the chair of botany, in succession to Professor R. W. Phillips, who retires after thirty-eight years' service.

J. A. S. WATSON has been promoted to the chair of agriculture and rural economy at Edinborough, in succession to Professor Robert Wallace, retired. Professor Watson was demonstrator in botany under Sir Isaac Bayley Balfour, afterwards continuing his studies in Germany, America, and Canada.

DISCUSSION AND CORRESPONDENCE

THE FOOD HABITS OF SWORDFISH

THE recent note of Mr. C. H. Townsend ("Swordfish Taken on Trawl Lines," SCIENCE, Vol. 56, p. 18) brings up the question of whether these fishes descend to considerable depths for food. On this point I have some evidence which may be worthy of record.

The late Captain John Toothaker of South Harpswell, Maine, was always very helpful to the Harpswell Laboratory, and would bring in from his trips any of the peculiar animals he found while sword fishing. Some years ago he turned over to me a couple of deep sea fishes which he had taken in a swordfish stomach. I have forgotten the genus and species, but both belonged to the Scopelidæ, and as I recall looking the matter up, the species had never been taken in less than 800 fathoms. The specimens were quite fresh and the digestive juices had hardly affected the integument, and the phos-

phorescent organs along the sides were in good condition. One of the specimens was given to the Boston Society of Natural History as a member of the New England fauna; the other was presented to the Museum of Comparative Zoology at Harvard. The swordfish was taken on the eastern border of the Georges Banks, a little inside the 500 fathom line. From this it would appear that the swordfish do descend to considerable depths for their meals, and, from the good condition of the specimens, it would appear that they make a rapid transition from the feeding grounds to the surface for the after-dinner siesta.

J. S. KINGSLEY

2500 CEDAR STREET,
BERKELEY, CALIFORNIA

EXPERIMENTAL TRANSFORMATION OF THE SMOOTH-BLADDER OF THE DOG

THE essential difference between the pale smooth muscle of the bladder and the red involuntary striated muscle of the heart is dependent upon the differential intensity of the hydro-dynamic pressure to which the vesicular and cardiac mesenchymal cells have been subjected, respectively. By experimentally varying the velocity of application and the intensity of the intra-vesicular pressure, which causes tension of the smooth bladder muscle, during a period of eight weeks, to a point comparable with that found in the heart the non-striated bladder muscle is transformed histologically into cross-striated muscle, and physiologically into an organ manifesting rhythmicity as long as the hydro-dynamic pressure stimulus is applied.

From the dynamic or functional, embryological viewpoint the various muscles, smooth, cardiac and skeletal represent differences in the amount of *work* that has been done upon them by the differential growing parts of the embryo during the active periods of growth.[1] The essential difference then physiologically between the various muscles is their capacity for work which in turn is dependent upon the amount of work that has been expended in their production. The reason for the different degrees of energy possessed by the types of muscle is purely an embryological bio-mechanical problem and corresponds to the differential amount of optimum tension which these muscles have experienced during their formative period because of a dominant energetic zone extrinsic to the region of myogenesis. The evidence presented by these experiments warrants the conclusion that as regards cross-striated muscle, function determines structure and not the reverse.

The writer wishes to thank Dr. Charles R. Bardeen, University of Wisconsin, for rechecking the evidence leading to the above conclusions.

EBEN J. CAREY
MARQUETTE UNIVERSITY MEDICAL SCHOOL,
MILWAUKEE, WISCONSIN

AN ALBINO MUTATION OF THE DEMATIACEOUS FUNGUS BRACHYSPORIUM TRIFOLII

THIS fungus has been under study in culture since October, 1919, when it was first isolated from clover plants. A description was published in *Phytopathology*, October, 1920, and an intensive culture study of the fungus has been continued since that time. The cultures were started from a single spore and have been kept going as a pure strain ever since.

The normal fungus is of the dematiaceous type, with dark brown hyphæ, forming in culture a very dense black mat on and in the medium.

On one of a series of cultures made early in November 1921 there appeared, starting from the point of inoculation, a sector of growth which completely lacked the black-brown color of the normal mat. A microscopic examination showed that the mycelium and conidia of this light-colored area were morphologically identical with those of the normal growth of the fungus, except for the lack of the dark brown color.

Isolation cultures were made of this albino material by the isolation of sclerotia-like

[1] Carey, E. J., 1919-20, *Journ. of Gen. Physiol.*, (*a*) ii, 357; (*b*) iii, 61; (*c*) *Anat. Record*, 1920, xix, 199.

bodies which are formed abundantly on certain media. From these pure cultures were made and subcultures have been carried on through sixteen consecutive non-sexual generations, both by the single spore method and by ordinary transfers from one tube to another, without any variation in the appearance or nature of this strain. The mycelium in mass is a true albino or may at times take on a light flesh color.

Throughout an intensive study in culture covering thirty months' time, and employing every variation in condition that could be thought of as an influencing factor, there has been no ascus or sexual stage developed either in the normal or albino strain. With these facts in mind, it would seem that the phenomenon here reported can only be referred to some sudden change which occurred in the mycelium or conidia of the normal strain, and in any case has no connection with any sexual process.

The abruptness of this change, and the continual difference shown by contrasting cultures of the albino and the normal strain, is very striking. This change does not seem to fall into that class of somatic mutations so far reported in fungi which are usually described as a dwarfing or reduction of the development of the normal form, but it is a complete loss of the dark-color character which is typical for the normal original strain.

LEE BONAR.

CRYPTOGAMIC LABORATORY,
UNIVERSITY OF MICHIGAN

A DAMP CHAMBER FOR MICROSCOPES

IN the study of cultures of mycelia of fungi it is desirable that they be observed under the 4 mm. objective of the microscope without disturbing the hyphæ by transferring them to a microscopic slide and making a fresh mount in the usual fashion. The type of damp chamber described below has been found especially adaptable to this purpose. It affords a chamber of considerable volume, with a humidity which is constantly near the saturation point, and of such a proportion that the greater part of the enclosed space may be observed through the 4 mm. objective.

This damp chamber is a modification of the one used by Blaauw in his recent work on the growth and phototropism of roots. It is made by using a large-sized microscopic slide, 2 x 3 inches, and a large-sized No. 2 coverglass, 45 x 72 mm., such as are used for making mounts of brain sections. These two pieces of glass are separated by several layers of filter paper, the central portions of which have been cut out, so that the filter paper is in the form of a frame about 5 mm. in width. Slits in this frame may be made for the purpose of ventilating the chamber, if such is desired.

The mount is made by placing the filter paper frame on the slide, then dropping a bit of nutrient agar just on the inner edge of the frame and inoculating it with the fungus to be studied. The large-sized coverglass is then placed over the filter paper and the mount is bound together with white linen thread and placed erect in a tumbler containing a little water. It is desirable that the mount be kept in a place which is slightly cooler than the room in which it is to be examined in order that the condensation of water on the inner surface of the coverglass may not interfere with observations.

This damp chamber has been found by the writer to be an excellent means of preparing mycelia of fungi for use in general courses in botany. Mounts so constructed can be used repeatedly in successive sections of the same or different classes. For this purpose only the low-power, 16 mm., objective is necessary and therefore the coverglass referred to above may be replaced by another large-sized slide, making the damp chambers much less expensive. The details of the structure of the hyphæ are well shown, the normal position in which they develop, and the streaming of the protoplasm in the hyphæ of Rhizopus, for example, are very distinct. Also the general form and arrangement of the fruiting bodies may be studied here.

By making a slit in the filter paper frame at one end, this damp chamber may be advantageously used for the study of roots and root-hairs. A seedling with a radicle a centimeter or more in length may be inserted in the slit and development allowed to proceed. This method of the study of root-hairs even under low power is found to be far superior

to the fresh mounts commonly used. The writer has found this damp chamber especially well adapted to the study of the relationship of fungous hyphæ to roots, both in the study of tropisms and in the actual observation of root-hair infections.

CLIFFORD H. FARR
THE STATE UNIVERSITY OF IOWA

THE COST OF GERMAN PUBLICATIONS

TO THE EDITOR OF SCIENCE: Apropos of the cost of German publications to Americans, it may be interesting to note the cost of membership in the Deutsche Chemische Gesellschaft (including subscription to the *Berichte* and *Zentralblatt*) to Germans and to others. The figures are computed on to-day's exchange rate:

United States			$23.00
England	115	shillings	25.56
France	305	francs	25.28
Belgium	316	francs	24.74
Italy	536	lira	24.55
Norway	176	kroner	28.09
Sweden	104	kroner	27.14
Denmark	124	kroner	26.60
Holland	69	gulden	26.71
Switzerland	91	francs	17.47
Germany	370	marks	.81

It will be noted that Americans fare better than any other nationals except the Swiss. It might be added that in 1921 the subscription for Americans was $16.00.

But do the Germans expect us to believe that the disparity between the cost to themselves and to others is, as was stated by the president of the Gesellschaft, due to the low value of exchange?

JAS. LEWIS HOWE
LEXINGTON, VIRGINIA

QUOTATIONS

SCIENCE AND THE TROPICS

FROM the late Mr. Chamberlain onwards, successive colonial secretaries have shown a far-sighted appreciation of what science may do for the tropics. The London School of Tropical Medicine, inaugurated and fostered by the Colonial Office, is now a world-center of research and education in the diseases prevalent in warm climates and the measures for resisting them. In another column Sir Arthur Shipley, now happily restored to economic zoology from his arduous and successful tenure of the vice-chancellorship of Cambridge, describes the work of the Imperial Bureau of Entomology, a product of a research committee appointed by the Marquess of Crewe when colonial secretary, and firmly established by the late Viscount Harcourt and Viscount Milner. Its local habitation is rightly placed at the Natural History Museum, which contains the finest collection of insects in the world. It is in close touch with every part of the empire, receives, examines, and identifies specimens sent to it, and acts as a general headquarters in the war against insects, whose successful prosecution is almost a condition of human existence. A third very practical application of science to the needs of the empire, due to the initiation of Viscount Milner when colonial secretary, applies specially to the tropics. A College for the Study of Tropical Agriculture is to open its first session at St. Augustine, Trinidad, this autumn. Last year we were able to welcome the constitution of a governing body to carry out the details of the scheme. Sir Arthur Shipley, chairman of the governors, and his distinguished colleagues have selected a competent staff and devised practical courses extending over three years for a diploma, and shorter periods for training in special subjects or for postgraduate research. The island of Trinidad has provided the site and a handsome grant towards the erection of the buildings, which are now complete. Private persons and commercial companies interested in tropical produce have made benefactions, and other West Indian islands are to contribute towards maintenance. But the benefits of the college in Trinidad will radiate far beyond the Antilles. The conditions of soil and climate which favor the luxuriant growth of tropical fruits, vegetable oils, rubber, and woods also favor the growth of animal and vegetable pests. Insects and moulds which no more than maintained existence in the jungle proliferate under the conditions of cultivation. Much can be done towards identifying and studying these in the museums and laboratories at home, and something also towards the devising of treatment.

But the detection of the early stages, discrimination between methods of treatment, and determination of the most suitable times and modes of applying these can be adequately pursued only in the field. The work of the professors of entomology and of mycology will be eagerly watched in many parts of the empire, and the men they train will have no difficulty in finding useful spheres when the demands of the West Indian islands have been satisfied.—The London *Times*.

SCIENTIFIC BOOKS

Mathematical Philosophy. A study of fate and freedom. Lectures for educated laymen. By CASSIUS J. KEYSER. Pp. xiv + 466. New York: E. P. Dutton and Company.

The common saying, "What man would be a philosopher who might be a mathematician" does not seem to apply to the author of this book, who tells us in the preface that for more than two score years he has "meditated upon the nature of mathematics, upon its significance in thought, and upon its bearing on human life." The book is in the form of twenty-one lectures designed primarily for students whose major interest is in philosophy but it aims to appeal to a much wider circle of readers, including professional mathematicians and the "growing class of those natural-science students who are interested in the logical structure and the distinctive method of mathematics regarded not only as a powerful instrument for natural science but also and especially as the prototype which every branch of science approximates in proportion as its basal assumptions and concepts become clearly defined."

The last lecture of the book is on science and engineering. In this lecture the author considers various definitions of engineering and then proposes the following: *The science and art of directing the time-binding energies of mankind—the civilizing energies of the world,—to the advancement of the welfare of man.* The language of this definition portrays the type of language used throughout the volume. The reader may at times feel that the language is too flowery to convey much real information, but he will generally find that the words are far from empty. Even in the more mathematical parts of the book, where the author speaks of the infinite abelian group of angel flights and discusses the question whether mind is a group, will frequently disclose much careful thought in what might at first appear to be superficial statements.

Professor Keyser has for a long time been preeminent among American mathematicians as regards a certain type of popularization and the present volume is perhaps, up to the present time, his most successful effort along this line. The scientist who wishes to acquire a knowledge of the nature and bearing of some of the fundamental mathematical concepts without going deeply into the subject will find here a unique opportunity. It is true that this knowledge is here presented in a sugar-coated form and that there is a danger that some of the readers may not get within this coating, but it is to be hoped that many others will become really interested in the subject matter and will give it sufficient thought to derive a lasting benefit therefrom. Teachers of mathematics will probably find here attractive features of their own subject which had escaped their attention. In fact, the present writer found the lecture devoted to the group concept worthy of a second reading although he had given much thought to this particular concept before reading this lecture.

The book under review occupies a unique and useful place in the mathematical literature of to-day. It deals with a considerable number of fundamental mathematical concepts, including those of transformation, invariance, infinity, hyperspace, group, variable and limit. Considerable attention is given to systems of postulates and the properties which are essential to a genuine system. In particular, it is noted that the Hilbert system of postulates for geometry is not intrinsically superior to others. On page 43 our author refers to the system of postulates "devised by the late Professor Hilbert and found in his famous 'Foundations of Geometry,'" which would naturally be construed to mean that Hilbert died before the publication of this book. This is fortunately not the case.

In the preface to his "Easy Mathematics," 1906, Sir Oliver Lodge stated that "the mathematical ignorance of the average educated person has always been complete and shameless." One cause of this ignorance has been the lack of popular and reliable books dealing with serious mathematical subjects. By the publication of the present volume Professor Keyser has rendered a very notable service towards the supply of such popular books. He has introduced into the book at various places somewhat serious doses of mathematics but these places are probably sufficiently separated by non-mathematical material to hold the reader who would not be interested in a book restricted to real mathematics.

G. A. MILLER

UNIVERSITY OF ILLINOIS

SPECIAL ARTICLES

THE "WINTER CYCLE" IN THE FOWL

THE idea of the superimposition of a Mendelian factor or factors determining the egg production of the "winter cycle" upon the factors determining the egg production of the normal or "reproductive cycle" has become widely familiar as an explanation of the phenomenon of the inheritance of fecundity in the domestic fowl.

In recent years there has been much skepticism among geneticists concerning the validity of this hypothesis. Crucial evidence for or against it is difficult to obtain.

Some light may be thrown upon the problem by the determination of the correlations between the egg records of the various "cycles" in the first and second laying year. If the birds of a flock differ fundamentally among themselves by reason of the presence in or absence from the zygotes from which they developed of Mendelian genes or factors determining their winter egg production, it would be logical to expect that the highest inter-annual correlation[1] would be that of the winter period. This must be considered true under the theory stated unless the further assumption be made that genes of factors which determine egg production during the "winter cycle" of the first laying year have no influence in determining production during the "winter cycle" of the second laying year.

We have, therefore, determined all possible correlations between the total egg records of the "cycles" of the first and of the second year for a series of 443 White Leghorn birds, for which complete records for the first two laying years are available.[2]

The correlations appear in the accompanying table. These show that for all four periods considered there is a higher correlation between the records of homologous periods than be-

[1] Harris, J. Arthur: "The Value of Inter-annual Correlations," *Amer. Nat.*, Vol. 49, 707-712, 1915.

[2] An exhaustive series of correlations for the egg records of the individual months of the first and second year was determined some months ago and is now in press in *Genetics*. The correlations for the total productions of the "cycles" have been only recently determined, because of the difficulty of dealing with the moments of such large numbers without grouping.

		Bird's First Year				
Bird's Second Year		Winter[3]	Spring[3]	Summer[3]	Autumn[3]	Annual
	Winter	+.3225 ± .0301 10.71[4]	+.0680 ± .0335 2.02	+.1269 ± .0331 3.83	+.3142 ± .0303 10.36	+.2955 ± .0307 9.62
	Spring	+.1177 ± .0332 3.54	+.3293 ± .0300 10.97	+.2060 ± .0322 6.39	+.1874 ± .0325 5.76	+.2782 ± .0310 8.97
	Summer	+.0976 ± .0333 2.93	+.3047 ± .0305 9.99	+.4272 ± .0275 15.53	+.2904 ± .0308 9.42	+.4026 ± .0282 14.27
	Autumn	+.2535 ± .0315 8.04	+.0369 ± .0336 1.09	+.2679 ± .0312 8.58	+.5545 ± .0233 23.79	+.4115 ± .0279 14.74
	Annual	+.3255 ± .0301 10.81	+.2352 ± .0318 7.39	+.3641 ± .0292 12.46	+.5127 ± .0248 20.67	+.5134 ± .0248 20.70

[3] The conventional limits of these "cycles" are as follows: Winter, November to February; spring, March to May; summer, June to August; autumn, September to October.

[4] Ratio of correlation coefficient to its probable error.

tween those which are not homologous. They show, furthermore, that the correlation between the winter periods of the first and second year is the lowest of any of the four correlations between the productions of homologous periods. The difference between the winter-winter correlation and the spring-spring correlation is not large, but the differences between the winter-winter correlation and the summer-summer and the autumn-autumn coefficients are more substantial, the two latter being 2.57 and 6.10 times as large as their probable error.

In so far as this type of evidence is pertinent to the problem, it indicates that in the White Leghorn at least there is no evidence of special factors which distinguish the "winter cycle" from any other period of the year.

J. ARTHUR HARRIS
H. R. LEWIS
STATION FOR EXPERIMENTAL EVOLUTION,
COLD SPRING HARBOR, N. Y.

THE EFFECT OF X RAYS ON CHEMICAL REACTIONS

WHILE investigating with Dr. E. Dershem absorption coefficients for X rays, a brass cell with aluminum windows containing cyclohexanol was subjected to the X rays and afterwards opened. The contents showed very striking and unexpected consequences due to this exposure. The colorless hexanol had turned to greenish-blue, and later analysis showed that about 0.1 of a gram of copper had gone into solution.

The intensity of the X rays was so small, coming as a nearly monochromatic beam from a crystal grating, that the amount of chemical action produced was most surprising. The geometry of our apparatus and the power used by the X ray bulb enabled us to calculate the maximum energy which could be involved. Assuming the target and the crystal grating to be 100 per cent. efficient, and taking one hour as the maximum time exposure, the energy received by the cell could not be greater than 3×10^6 ergs, or less than 0.1 of a calorie.

Using the quantum theory, we may calculate from the wave length, approximately 0.2 Å, the number of quanta entering the cell. The energy per quantum is 1×10^{-7} ergs. Therefore the number of quanta received could not be greater than 3×10^{13}. Since about 0.1 gram of copper went into solution each quantum must have caused at least 3.3×10^7 atoms of copper to react.

The small amount of energy involved, and the small number of quanta relative to the number of atoms reacting, indicate that the reaction is an exothermal one. The quantum voltage producing the X rays was approximately 10^5 volts. Since each quantum caused 3.3×10^7 atoms to react, not more than 3×10^{-3} volts could be expended on each atom if the reaction were endothermal. This value is only one five-hundredth of the smallest known resonance potential, that for cæsium as determined by Foote, Rognley and Mohler,[2] being 1.48 volts.

We therefore must conclude that the X rays produced some sort of trigger action of the type studied by Bodenstein and Taylor[3] and by Jorissen and Ringer[4] in their work on the formation of hydrochloric acid from hydrogen and chlorine by means of alpha particles. An excellent discussion of this work will be found in a monograph by Lind.[5]

Mesitylene showed a behavior similar to that of cyclohexanol, but in this case the color was a yellowish green. This difference in color may be due to concentration effects.

On account of the large effect produced by relatively small amounts of energy, it seems that the use of X rays may acquire great importance in the production of organic compounds, especially if substances are produced in this manner which can not be obtained by other means.

A. R. OLSON
National Research Fellow in Chemistry
UNIVERSITY OF CALIFORNIA,

[2] Foote, Rognley and Mohler, *Phys. Rev.*, 61 (1919).

[3] (M. Bodenstein) and H. S. Taylor, *J. Am. Chem. Soc.*, 37: 24 (1915).

[4] Jorissen and Ringer, Ber., 39: 2095 (1906).

[5] S. C. Lind, *The Chemical Effects of Alpha Particles and Electrons*, Chemical Catalog Co., New York (1921).